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graphic tactile cell can be provided in which assembly and exchange of components are easily performed and accordingly the maintenance is easily performed, while the degree of freedom in enlargement of the graphic tactile cell is large.

Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and obtained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

#### BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate presently preferred embodiments of the invention, and together with the general description given above and the detailed description of the preferred embodiments given below, serve to explain the principles of the invention.

FIG. 1 is a side view of a cell unit of a graphic tactile cell according to an embodiment of the present invention;

FIG. 2 is a partially cutaway perspective view of the cell unit of this embodiment;

FIG. 3 is a perspective view of the graphic tactile cell of this embodiment which is constituted by a combination of cell units;

FIG. 4A is a cutaway perspective view of a cell unit to explain an example of a finger touch detection means; and

FIG. 4B is a cutaway perspective view of a cell unit to explain another example of the finger touch detection means.

#### DETAILED DESCRIPTION OF THE INVENTION

A graphic tactile cell according to the preferred embodiment of the present invention will be described with reference to the accompanying drawing. FIGS. 1 and 2 are side and perspective views, respectively, of a cell unit serving as the constituent unit of the graphic tactile cell of this embodiment. FIG. 3 is a perspective view of a graphic tactile cell in which a required graphic tactile surface is formed by coupling a plurality of cell units in the vertical and horizontal directions.

Referring to FIGS. 1 to 3, reference numeral 1 denotes a cell unit serving as the constituent unit of the graphic tactile cell. A combination of a plurality of cell units 1 constitutes a desired graphic tactile cell. In the cell unit 1, a unit base 2 molded of a synthetic resin or the like to hold unit constituent components serves as the main body of the structural mechanism. A tactile portion 2a located at the upper portion of the unit base 2 to indicate the graphic pattern holds right and left arrays of a total of 16 tactile pins 3 to be vertically movable. The front and back surfaces of a rhombic middle plate 2b which is below the tactile portion 2a of the unit base 2 to be in oblique contact with it obliquely hold 16 piezoelectric element segments 4 corresponding to the respective tactile pins 3 at a predetermined angle. A plurality of partition walls 2c for holding the piezoelectric element segments 4 to regulate their positions are formed on the front and back surfaces of the middle plate 2b to correspond to the respective piezoelectric element segments 4. A spacer plate 2d is formed on the upper right (in FIG. 1) surface of the middle plate 2b to serve also as the partition wall 2c and to maintain the distance to an adjacent cell unit. Through holes 2f, through which the tactile pins 3 project from the upper surface of a tactile surface 2e, are formed in the tactile portion 2a serving as the graphic tactile surface.

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Pin stoppers 3a to abut against free ends 4a of the piezoelectric element segments 4 are formed on the lower portions of the tactile pins 3 that extend through the through holes 2f. The lower surfaces of these pin stoppers 3a that abut against the piezoelectric element segments 4 are formed at an angle to be substantially parallel to the free ends 4a of the piezoelectric element segments 4. The lower surfaces of the tactile pins 3 always abut against the free ends 4a of the piezoelectric element segments 4 to be parallel to them.

Lower proximal ends 4b of the piezoelectric element segments 4 are fixed to the lower portion of the unit base 2 through plastically deformable adjusting members 5 made of, e.g., soft copper. Fulcrums 2g serving as the nodes of the bending motion are formed at the intermediate portion of each partition wall 2c of the middle plate 2b close to the proximal end 4b of the piezoelectric element segment 4, to sandwich the corresponding piezoelectric element segment 4. The respective piezoelectric element segments 4 are thus supported by the unit base 2.

To drive the piezoelectric element segments 4 supported in this manner, lead wires 4c (not shown in FIG. 1) for connecting the piezoelectric element segments 4 and an arithmetic drive unit 6 with each other connect the piezoelectric element segments 4 and the arithmetic drive unit 6 through lead wire insertion grooves 2h formed in the unit base 2 near the proximal ends 4b. This arithmetic drive unit 6 drives a required piezoelectric element segment 4 through a connector 6a upon reception of an external input signal, and monitors the displacement of each piezoelectric element segment 4.

With this structure, when a positive voltage is applied to one surface of the piezoelectric element segment 4, this piezoelectric element segment 4 is bent, and its free end 4a is moved upward to push the corresponding tactile pin 3 upward. When a negative voltage is applied to the opposite surface of the piezoelectric element segment 4, this piezoelectric element segment 4 is bent to the opposite side, and the tactile pin 3 is moved downward. The person who touches the tactile pins 3 discriminates a graphic pattern from the vertical movement of the tactile pins 3.

In this embodiment, a finger touch detection means for informing the person who touches the tactile pins 3 of the finger touch position on the graphic tactile surface is arranged for each cell unit 1. Reference numeral 7 in FIG. 1 denotes a strain sensor adhered to the bent portion of the corresponding piezoelectric element segment 4 for this purpose. A lead wire (not shown) for outputting a change in output of the strain sensor 7 is connected to the arithmetic drive unit 6, in the same manner as the lead wire 4c of the piezoelectric element segment 4. When the piezoelectric element segment 4 to which the strain sensor 7 is adhered is bent upon a finger touch, the strain sensor 7 is strained and its resistance is changed. This change is sent to the arithmetic drive unit 6 through a bridge circuit or the like, thereby detecting a finger touch. Even if the piezoelectric element segment 4 is bent not by a finger touch but for the purpose of indicating a graphic pattern, the resistance of the strain sensor 7 changes. In this case, since a required voltage is applied to the piezoelectric element segment 4, this bend can be easily discriminated from a bend caused by a finger touch by referring to the drive voltage of the piezoelectric element segment 4 in the arithmetic drive unit 6.

FIGS. 4A and 4B show other finger touch means. FIG. 4A shows an embodiment in which a thin pressure sensor 8 is adhered on the surface of a tactile surface 2e to serve as a finger touch detection means. As the pressure sensor 8, a switch mechanism is known in which a rubber-like base dispersed with a metal powder at a high density is arranged between upper and lower conductive members whose finger touch surfaces are insulated in a known manner. When a